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INFLUENCE OF LAND PREPARATION METHODS AND PLANTING GEOMETRY ON YIELD AND ENGINEERING PARAMETERS OF MACHINE TRANSPLANTED RICE (ORYZA SATIVA L.)

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ABSTRACT

Field experiment on "Effect of land preparation methods and planting geometry on yield and engineering parameters of machine transplanted rice (Oryza sativa L.)" was conducted at Agricultural Research Station, Gangavathi, University of Agricultural Sciences, Raichur, Karnataka during kharif, 2012 and 2013 in clay soil under irrigated condition. Pooled mean indicated that, puddling with rotovator fb levelling with spike tooth harrow and plating at a spacing of 30 x 21 cm recorded significantly higher grain yield (4906 and 5192 kg ha^{-1}, respectively) and straw yield (6247 and 6508 kg ha^{-1}, respectively). Engineering parameters like lower fuel consumption (38.11 and 42.20 liter ha^{-1}, respectively), higher area coverage (0.182 and 0.194 hour ha^{-1}, respectively) and transplanting time (77.10 and 80.76 %, respectively), lower time lost in turning (3.87 and 4.65 %, respectively) and adjustment/repair (11.89 and 8.72 %, respectively). Significantly higher Gross returns (` 87,733 and 92,779 $ha^{-1}$), net returns (` 46,329 and 50,007 ha^{-1}) and B:C of 2.14 and 2.20 were noticed with puddling by rotovator fb levelling with spike tooth harrow and planting geometry of 30 x 21 cm other methods of land preparation and planting geometry.

KEYWORDS: Land Preparation Methods, Planting Geometry, Machine Transplanting, Manual Planting, Engineering Parameters

INTRODUCTION

Rice (Oryza sativa L.) is considered as the "global grain". It is the major staple food for more than half of the global population. Asian countries consume about 90 per cent of the rice grown and produced in the world and supplies 50 to 80 per cent calories of energy to Asians. Rice is the anchors of food security in the world with challenges of climate change which is grown under wide range of latitudes and altitudes (Anon., 2008).

At the moment farmers owning tractors normally hold and use conventional cultivator for preparing rice fields. The cultivator is the only soil opening tool. It has less pulverizing action and least sealing effect at any level. As a result, many repeats of cultivator followed by planking are required to transform the soil into condition where rice nursery can be transplanted. The only combination of cultivator and plank tend to compact the surface of soil instead of transforming impermeability below the root zone. Such practice entails poor land manipulation at the cost of energy, time and machinery life and low yield of rice. The study of inter-relationship of soil, implement and crop is very much required.

Spacing is very important for optimum plant population per unit area and will be reflected on the yield of the crop. A dense population of crops may have limitations in the maximum availability of resource factors. It is, therefore, necessary to determine the optimum density of plant population per unit area for obtaining maximum yield. Optimum plant spacing ensures plants to grow properly both in their aerial and underground parts through different utilization of solar radiation and nutrients.

Mechanical transplanting facilitates better stand establishment of the rice crop at right time. Therefore, it is high time for mechanizing the transplanting operation in rice cultivation. Mechanical transplanter using self-propelled transplanter has been considered as the most promising option because it saves labour to the tune of 90 per cent of that required in manual transplanting, minimizes stress and drudgery, ensures timely transplanting and attains optimum plant density contributing to higher productivity (Behera, 2000). Thus a study was conducted to know the effect of land preparation practices and different planting geometry on growth and yield of machine transplanted rice.

MATERIALS AND METHODS

A field experiment was conducted at Agricultural Research Station, Gangavathi, University of Agricultural Sciences, Raichur, during kharif, 2012 and 2013. The experiment was laid in strip-plot design. The soil of the experimental site was medium deep black clay with soil reaction (8.2), electrical conductivity (2.1), available N (247.2 kg ha^{-1}), available P_2O_5 (50.2 kg ha^{-1}) and available K_2O (357.6 kg ha^{-1}) at surface 0-20 cm soil depth.

Agricultural Research Station, Gangavathi is situated in the Northen Dry Zone of Karnataka between 15^o 15' 40" North latitude and 76^o 31' 40" East longitude at an altitude of 419 m above mean sea level and represents irrigated transplanted rice belt of Tungabhadra command area. The experiment consisted three different land preparation methods viz., L_1 : passing of cultivator twice fb puddling with disc puddler fb levelling with spike tooth harrow - Farmers practice, L_2 : puddling with rotovator fb levelling with spike tooth harrow and L_3 : puddling with rotomixure fb levelling with spike tooth harrow and three planting geometry planted by transplanter viz., S_1: 30 x 7 cm, S_2: 30 x 14 cm and S_3: 30 x 21 cm along with manual transplanting with 20 x 10 cm spacing (S_4). The land was prepared using tractor drawn cultivator twice, followed by puddling twice with disc puddler and finally levelled using tractor drawn spike tooth harrow in case of farmers practice. Second type of land preparation was puddling with rotovator followed by levelling using tractor drawn spike tooth harrow. The other one was puddling with rotomixure and levelling was done using spike tooth harrow and kept ready for planting and seedlings raised in the trays were planted in the main field. Six days after transplanting, butachlor 50 EC at the rate of 2.5 liter ha^{-1} was sand mixed and broadcasted uniformly over the field containing a thin film of water followed by two hand weedings at 20 and 40 days after transplanting. From the day of transplanting upto 10 days, a thin film of water was maintained and thereafter 5 cm standing water was maintained upto 10 days before harvesting. Water was drained during fertilizer application and spraying of chemicals. Recommended dose of fertilizers (150:75:75 and 20 kg N: P_2O_5 : K_2O and $ZnSO_4$ /ha) were applied as per the recommendation and time. Urea, Di-ammonium phosphate (DAP) and Muriate of potash (MOP) were used to supply N, P and K respectively. Before application, the land was drained and fertilizers were uniformly broadcasted over the field followed by letting in of water 24 hours after application. To control leaf folder and stem borer, Monocrotophos @ 1000 ml ha^{-1} was sprayed at 25 and 50 days after transplanting and one spray of Streptomycin sulphate @ 60 g ha^{-1} was taken up to control the bacterial leaf blight. Similarly to control brown plant hopper, one spray of Buprofezin and DDVP @ 625 ml and 625 g ha^{-1} were taken up during both the years of study. The crop was harvested at physiological maturity, threshed and cleaned manually in both the years. Both grain and straw were

sun dried for a week and dry weights were recorded. For computing the cost of cultivation, different variable cost of items was considered. The cost includes expenditure on seeds, fertilizers, irrigation, plant protection chemicals, hiring charges of tractor, transplanter, fuel cost and labour charges prevailed in market during 2012 and 2013.

RESULTS AND DISCUSSION

Yield

Land preparation methods and planting geometry had significant influence on yield of rice. Significantly higher grain yield (4906 and 5192 kg ha^{-1}, respectively) and straw yield (6247 and 6508 kg ha^{-1}, respectively) were recorded with puddling by rotovator fb levelling with spike tooth harrow method of land preparation and 30 x 21 cm spacing over passing of cultivator twice fb puddling with disc puddler fb levelling with spike tooth harrow and manual planting at a distance of 20 x10 cm. The higher yield of rice in case of puddling with rotovator fb levelling with spike tooth harrow and 30 x 21 cm spacing was mainly due to the fact reduction in bulk density and cone index in the plough layer because of puddling with rotovator compared to other land preparation methods. These results are similar with the findings of (Rahamati and Solakhe, 2001) and (Tripathi et al. 2004). (Duraisamy et al. 2011), (Naidu et al. 2013) and (Rasool et al. 2013) also reported increased rice grain yield due to wider spacing. Grain and straw yield of machine transplanted rice was influenced significantly due to interaction of land preparation methods and spacing between the plants. Puddling with rotovator fb levelling with spike tooth harrow and intra plant spacing of 30 x 21 cm treatment combination recorded significantly higher grain and straw yield (5388 and 6789 kg ha^{-1}, respectively) over rest of the treatment combinations.

Nutrient Uptake and Availability

Results revealed that significantly higher total uptake of nitrogen, phosphorous and potassium were recorded by puddling with rotovator fb levelling with spike tooth harrow and planting geometry of 30 x 21 cm (106.49 and 121.16, 36.42 and 39.51, 74.90 and 81.49 kg ha^{-1}, respectively) Similar findings were also reported by (Naidu et al. 2013). Maximum soil available nitrogen, phosphorous and potassium were recorded by passing of cultivator twice fb puddling with disc puddler fb levelling with spike tooth harrow and manual planting at spacing of 20 x10 cm (244.2 and 254.2, 50.64 and 54.93, 353.91 and 354.69 kg ha^{-1}, respectively). Lower uptake and subsequently lower grain and straw yield in these treatments perhaps may be the reason for higher available nutrients in the soil after harvest.

ENGINEERING PARAMETERS

Methods of Land Preparation

Puddling with rotovator fb levelling with spike tooth harrow method of land preparation recorded significantly lower fuel consumption (38.11 liter ha^{-1}), higher area coverage (0.182 ha/hour), transplanting time (77.10 %), lower loss of time due to turning (3.87 %) and adjustment/repair (11.89 %) over passing of cultivator twice fb puddling with disc puddler fb levelling with spike tooth harrow. While time lost due to mat feeding did not show any significant difference. The lower fuel consumption, higher area coverage and higher transplanting time was mainly due to the fairly levelled land created by this combination of land preparation, wherein uniform depth of standing was maintained and also due to non excessive puddling which inturn facilitated smooth movement of transplanter. These findings are in accordance with (Sahay et al. 2002).

Planting Geometry

Planting geometry of 30 x 21 cm recorded significantly higher area coverage (0.194 ha/hour), transplanting time (80.76 %), lower loss of time due to mat feeding (5.88 %) and adjustment/repair (8.72 %) over manual transplanting at a spacing of 20 x 10 cm. However, fuel consumption and time lost in turning did not differ significantly. The possible reason might be that, labour might need more time to adjust for different puddled condition of soil for planting the seedlings. These results corroborate with (Choudhary et al. 2005) and (Manjunatha et al. 2009).

ECONOMICS

Methods of Land Preparation

Puddling with rotovator fb levelling with spike tooth harrow recorded significantly higher gross returns (` 87,773 and 92,779, respectively ), net returns (` 46,329 and 50,007, respectively) and B:C (2.14 and 2.20, respectively) when compared to passing of cultivator twice fb puddling with disc puddler fb levelling with spike tooth harrow and manual planting at a spacing of 20 x10 cm. The increased net returns in these treatments were correlated to the higher grain and straw yield. Interaction effect due land preparation and intra plant spacing on gross returns (` 96,316 $ha^{-1}$) and net returns (` 54,649 ha^{-1}) was significant with puddling by rotovator fb levelling with spike tooth harrow and planting geometry of 30 x 21 cm treatment combination when compared to rest of the treatment combinations.

CONCLUSIONS

From the present investigation, it may be concluded that, Puddling with rotovator fb levelling with spike tooth harrow and planting geometry of 30 x 21 cm were found to be the best method of land preparation and planting geometry for transplanting of rice by self propelled mechanical transplanter.

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Table 1: Grain Yield, Straw Yield, Total Nutrient Uptake by Machine Transplanted Rice as Influenced by Land Preparation Methods and Planting Geometry Pooled Data of 2 Years)

Treatments	Grain Yield (kg ha^{-1})	Straw Yield (kg ha^{-1})	Total nutrient uptake (kg ha^{-1})		
			Nitrogen	Phosphorous	Potassium
Main Treatments (L)					
L_1	4525	5648	96.72	34.11	70.33
L_2	4906	6247	106.49	36.42	74.90
L_3	4800	5870	101.44	35.53	72.69
S.Em.±	50	104	**1.59**	0.35	0.74
C.D. (P=0.05)	196	409	**6.24**	1.39	2.90
Sub Treatments (S)					
S_1	4589	5747	94.35	34.37	70.25
S_2	4861	6152	107.55	36.58	75.13
S_3	5192	6508	121.16	39.51	81.49
S_4	4334	5280	83.13	30.89	63.67
S.Em.±	78	132	**2.98**	0.69	1.58
C.D. (P=0.05)	269	457	**10.31**	2.39	5.46
Interaction (L x S)					
L_1S_1	4329	5738	88.32	33.29	68.32
L_1S_2	4766	5871	99.95	35.15	72.00
L_1S_3	4672	5632	94.80	34.67	70.44
L_1S_4	4792	6040	103.92	35.83	73.37
L_2S_1	4923	6326	111.96	37.48	76.79
L_2S_2	4867	6089	106.78	36.44	75.25
L_2S_3	5388	6789	115.21	38.43	76.37
L_2S_4	5118	6441	127.36	40.39	79.33
L_3S_1	5071	6293	120.92	39.72	77.32
L_3S_2	3862	4375	79.44	28.88	68.70
L_3S_3	4548	6001	86.68	32.48	71.39
L_3S_4	4592	5465	83.27	31.30	70.92
S.Em.±	103	217	**3.64**	1.14	1.74
C.D. (P=0.05)	318	668	**NS**	NS	NS

NS – Non significant
L_1: Cultivator (twice) fb pudling with disc puddler fb spike tooth harrow (PF)
L_2: Puddling with rotovator fb spike tooth harrow
L_3: Puddling with rotomixture fb spike tooth harrow
S_1: 30 x 7 cm S_2: 30 x 14 cm S_3: 30 x 21 cm S_4: 20 x 10 cm

Table 2: Soil Available Nutrients After Harvest and Engineering Parameters of in Machine Transplanted Rice as Influenced Land Preparation Methods and Planting Geometry (Pooled Data of 2 Years)

Treatments	Available soil nutrients (kg ha^{-1})			Fuel Consumption (liter ha$^{-1)}$	Area Coverage (ha/hr)	Transplanting Time (%)
	Nitrogen	Phosphorous	Potassium			
Main Treatments (L)						
L_1	244.2	50.64	353.91	45.80	0.169	74.01

L_2	233.7	47.04	333.12	38.11	0.182	77.10
L_3	241.3	48.83	341.00	43.06	0.176	75.58
S.Em.±	1.96	068	3.63	0.97	0.002	0.49
C.D. (P=0.05)	7.69	2.65	14.24	3.80	0.007	1.91
Sub Treatments (S)						
S_1	246.3	49.90	347.96	42.23	0.187	79.74
S_2	232.6	46.90	336.47	42.44	0.190	80.38
S_3	225.8	43.62	331.48	42.30	0.194	80.76
S_4	254.2	54.93	354.69	42.31	0.131	61.36
S.Em.±	3.31	1.56	2.39	1.01	0.003	0.69
C.D. (P=0.05)	11.47	5.39	8.24	NS	0.010	2.39
Interaction (L x S)						
L_1S_1	225.6	45.96	325.80	45.81	0.179	77.97
L_1S_2	237.0	47.82	345.65	37.87	0.194	81.20
L_1S_3	235.3	46.92	340.50	43.01	0.188	80.05
L_1S_4	240.5	48.42	332.20	45.77	0.182	78.18
L_2S_1	251.7	51.86	350.40	38.44	0.199	82.68
L_2S_2	246.8	49.42	348.60	43.12	0.191	80.28
L_2S_3	248.4	52.74	345.30	45.81	0.184	78.68
L_2S_4	259.0	57.69	341.75	38.08	0.204	83.03
L_3S_1	255.1	54.37	340.50	43.02	0.194	80.58
L_3S_2	220.4	41.02	357.00	45.79	0.131	61.20
L_3S_3	229.3	45.17	349.05	38.04	0.130	61.48
L_3S_4	227.9	44.61	326.35	43.10	0.131	61.39
S.Em.±	4.90	1.56	4.05	1.23	0.007	1.04
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS

NS – Non significant

L_1: Cultivator (twice) fb pudling with disc puddler fb spike tooth harrow (PF)

L_2: Puddling with rotovator fb spike tooth harrow

L_3: Puddling with rotomixture fb spike tooth harrow

S_1: 30 x 7 cm S_2: 30 x 14 cm S_3: 30 x 21 cm S_4: 20 x 10 cm

Table 3: Time Lost Due to Mat Feeding, Turning Loss, Machine Adjustment/ Repair, Gross Returns, Net Returns and b:c of Machine Transplanted Rice as Influenced Land Preparation Methods and Planting Geometry (Pooled Data of 2 Years)

Treatments	Mat Feeding Time (%)	Turning Loss (%)	Adjustment/ Repair (%)	Gross Returns (` ha^{-1})	Net Returns (` ha^{-1})	B:C
Main Treatments (L)						
L_1	7.29	6.07	12.61	80832	36212	1.83
L_2	7.15	3.87	11.89	87733	46329	2.14
L_3	7.11	5.07	12.25	85666	44104	2.09
S.Em.±	0.15	03.0	0.14	905	1229	0.03
C.D. (P=0.05)	NS	1.20	0.48	3552	4826	0.10
Sub Treatments (S)						
S_1	6.07	5.28	8.90	81984	39539	1.95
S_2	5.98	4.84	8.80	86886	44294	2.07
Table 3 – Cond.,						
S_3	5.88	4.65	8.72	92779	50007	2.20
S_4	10.80	5.25	22.61	77325	35019	1.86
S.Em.±	0.37	0.22	0.19	1304	1456	0.06
C.D. (P=0.05)	1.27	NS	0.64	4503	5040	0.20
Interaction (L x S)						
L_1S_1	6.20	6.46	9.32	77555	33033	1.76
L_1S_2	6.05	4.45	8.30	85083	43761	2.08

L_1S_3	5.95	4.93	9.08	83317	41825	2.03
L_1S_4	6.15	6.37	9.25	85642	40878	1.93
L_2S_1	5.93	3.15	8.25	88071	46659	2.15
L_2S_2	5.85	5.00	8.88	86946	45346	2.12
L_2S_3	6.09	6.02	9.22	96316	54649	2.33
L_2S_4	5.80	2.96	8.22	91460	46521	2.06
L_3S_1	5.76	4.97	8.70	90563	48854	2.20
L_3S_2	10.71	5.43	22.67	68673	24417	1.57
L_3S_3	10.80	4.93	22.80	81463	40249	2.00
L_3S_4	10.88	5.39	22.35	81840	40393	2.00
S.Em.±	0.71	0.50	0.50	1620	1795	0.06
C.D. (P=0.05)	NS	NS	NS	4992	5530	NS

NS – Non significant

L_1: Cultivator (twice) fb pudling with disc puddler fb spike tooth harrow (PF)

L_2: Puddling with rotovator fb spike tooth harrow

L_3: Puddling with rotomixture fb spike tooth harrow

S_1: 30 x 7 cm S_2: 30 x 14 cm S_3: 30 x 21 cm S_4: 20 x 10 cm

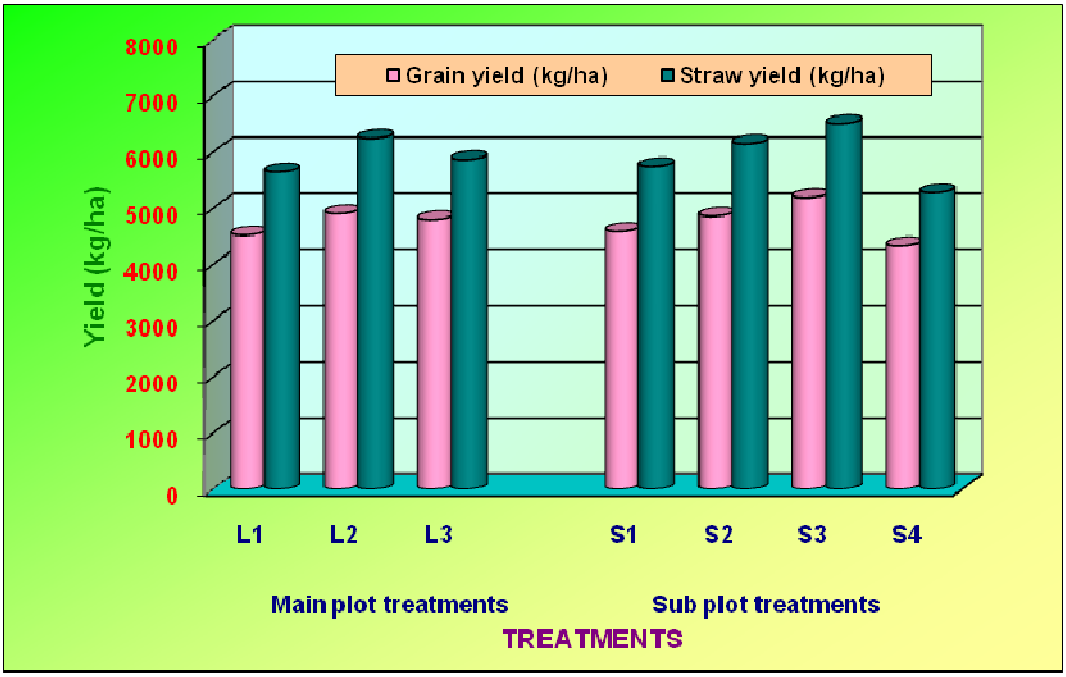

Figure 1: Grain and Straw Yield of Machine Transplanted Rice as Influenced Land Preparation Methods and Planting Geometry